REMARKS

Table 1 has been relabeled as FIG. 49. The other tables were renumbered. The specification has been corrected to reflect these changes. Claims 1 and 2 have been amended. Claims 3-28 have been canceled, without prejudice. The changes made to the specification and claims by the current amendment are attached hereto in a; page entitled, "Version with Markings to Show Changes Made." Claims 1 and 2 remain pending. Reconsideration and reexamination of the application, as amended, are requested.

Misspellings have been identified in FIGs. 1 and 25. Table 1 has been relabeled as FIG. 49. Tables 2-8 have been relabeled as Tables 1-7. Red-lined copies are enclosed for the Examiner's approval.

Applicants confirm the election of claims 1-3, without traverse.

The Examiner objected to the specification because of Table 1 including an illustration. As indicated, the tables have been relabeled, and the specification has been amended to reflect the change.

The Examiner rejected claim 1-3 under 35 U.S.C. § 103(a) as being obvious on consideration of JP07034190, JP07097656, JP09176785, JP07300653, or JP09176786.

We made a comparison between the present invention of claims 1 and 2 and the references N-R (as listed in PTO-892) with regards to the composition (please see the attached table).

An important difference between the present invention and the references N-R is the amount of C. Actually, the amount of C of the references covers that of the present invention (0.46-0.48). However, the amount of the present invention is limited to a very narrow range (0.02), while the range of the amount in the references is much broader. In the case of such a broad range, it is impossible to obtain a billet which does not need an intermediate annealing process when a product with high deformability is cold-forged. The object of the present invention is to provide a billet which enables a limiting upsetting ratio of 90% by improving a

billet for cold forging defined in the Japanese Industrial Standard, S48C, and the conception comes from narrowing the range of the C amount defined in JIS S48C (0.45-0.51).

A further comparison between the present invention and each reference is made. As described in the specification of the present application, the amount of Si, P, S and Cu is also important. Therefore, the comparison was made with regards to these:

Ref. N:

The amount of Si, P, S and Cu covers the present invention from the numerical viewpoint. However, the upper values are too large, which means that it is impossible to obtain a billet which enables a limiting upsetting ratio of 90% or more. Also there is no description of Cr.

Ref. O:

The upper values of P, S and Cu are too large. Also, there is no description of Cr.

Ref. P:

The upper values of Si, P and S are too large. These are one order larger than that of the present invention.

Ref. Q:

The same as the above-mentioned Ref. P.

Ref. R:

There is no description of Cu.

As mentioned above, the numerical limitation in the references is extremely broad. However, the range shown in the references does not enable an aspect ratio of 300% or less nor a limiting upsetting ratio of 90% or more. These matters can be achieved only in the case where the numerical limitation is specified in the same manner as the present invention.

Thus, Applicants have established that the billet of claims 1 and 2 have a required composition which either satisfies a required aspect ratio or the act of the specified upsetting

ratio. It has herein been established that none of the references disclose the specified composition such that the specified limitations are in fact satisfied. The billet of claims 1 and 2 are distinguished from each of the references. None of the references disclose or point to the compositions with the specified limitations. The Examiner has not established a *prima facie* case.

In view of the above, it is submitted that the application is in condition for allowance. Reconsideration and reexamination are requested. Allowance of claims 1 and 2 at an early date is solicited.

Respectfully submitted,

MERCHANT & GOULD P.C.
P.O. Box 2903
Minneapolis, MN 55402-0903
(612) 332-5300

Dated: Sept. 24, 2001

By Curtis B. Hamre
Curtis B. Hamre
Reg. No. 29,165
CBH:PSTcmz

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification

Paragraph beginning at page 27, line 1 has been amended as follows:

FIG. 47 is an enlarged view of an encircled portion C in FIG. 44; [and]

Please replace the paragraph beginning at page 27, line 3, with the following rewritten paragraph:

FIG. 48 is an enlarged schematic view showing the relationship between the radial position of a forming punch and the deformation of a die in a forming process[.]<u>; and</u>

Page 27, after line 6, the following paragraph was inserted:

<u>FIG. 49 is a table and illustration providing aspect ratio representing the spherodized ratio of carbide for materials 1, 2, and 3.</u>

Paragraph beginning at page 34, line 8 has been amended as follows:

As shown in [Table 1] <u>FIG. 49</u>, the aspect ratio (b/1 x 100) representing the spherodized ratio of carbide in each of the materials was 506 % for the material 1, 347 % for the material 2, and 300 % for the material 3.

Page 34, line 20, the heading has been deleted:

[Table 1]

Please replace the paragraph beginning at page 35, line 1, with the following rewritten paragraph:

In order to confirm the effectiveness of the material constituents according to the present invention, the results of an upsetting test are shown in Table [2] <u>1</u> below. The upsetting ratio

was 90 %, and the materials (billets) used in the upsetting test were spherodized before and after being drawn.

Page 35, line 7 has been amended as follows:

Table [2] 1

Paragraph beginning at page 42, line 18 has been amended as follows:

Table [3] 2 shown below indicates the results of an upsetting test and a crankshaft forming test on different materials and spherodizing processes.

Page 43, line 5 has been amended as follows:

Table [3] 2

Paragraph beginning at page 43, line 6 has been amended as follows:

It has been confirmed from Table [3] 2 that the billet processed by the method according to the third invention did not crack as with the billet which was subjected to spherodizing annealing before and after being drawn.

Paragraph beginning at page 43, line 11 has been amended as follows:

In Table [3] 2, the R material is a material that is air-cooled by the cooling bed, rather than being quenched, and the controlled rolling material is of a fine alpha structure produced by strictly controlling hot rolling conditions. Since the R material, even if annealed, tends to crack upon being forged, it has heretofore been customary to use the controlled rolling material. However, it can be seen that the controlled rolling material is caused to crack if it has been annealed once. It can also be seen that no cracking occurs if the material is annealed before and after being drawn, and the surface-hardened steel according to the present invention is not caused to crack even if it has been annealed once.

Paragraph beginning at page 55, line 10 has been amended as follows:

Crankshaft were cold-forged using a carbon steel having the composition shown in Table [4] 3 below, and aged for various heating times shown in Table [5] 4. The crankshafts were measured for surface (HRC) prior to the aging, surface hardness (HRC) subsequent to the aging, and internal hardness (HRC), and analyzed for metal crystal lattice constants by way of x-ray diffraction.

Paragraph beginning at page 55, line 18 has been amended as follows:

The temperature of the aging process was 300° C, and No. A in Table [5] 4 was not subjected to the aging process.

Page 55, line 21 has been amended as follows:

Table [4] 3

Page 55, line 22 has been amended as follows:

Table [5] 4

Paragraph beginning at page 56, line 1 has been amended as follows:

The correlations between the hardnesses (HRC) prior and subsequent to the aging process and the average lattice constants were compared with each other. The results are shown in Table [6] 5. It is found that the greater the average lattice constant (d value), the higher the hardness (HRC).

Page 56, line 7 has been amended as follows:

Table [6] 5

Paragraph beginning at page 57, line 10 has been amended as follows:

The foregoing effect is clearly seen from the analyzed results shown in Table [4] 3 - Table [6] 5. In Table [6] 5, the hardness is small in increase at items below No. C (aging time: 1.0 H), reaches its peak between No. D and No. F (aging time: 1.5 to 2.5 H), and is reduced due to excessive aging at No. G (aging time: 4 H).

Paragraph beginning at page 57, line 22 has been amended as follows:

Before aging, as shown in FIG. 36(b), arbitrary locations on the crankshaft were measured for surface hardness (HRC), and three crankshafts No. 1 - No. 3 were tested. The results are shown in Table [7] 6.

Page 57, line 26 has been amended as follows:

Table [7] 6

Paragraph beginning at page 58, line 1 has been amended as follows:

As shown in FIG. 36(c), the hardness measurement points after aging were 7 locations (1) - (7) on the crankshaft for surface and internal hardness. The results are shown in Table [8] 7:

Please replace the heading at page 58 line 5, with the following rewritten heading:

Table [8] 7

In the Claims

Claims 1 and 2 have been amended as follows:

1. (Amended) A billet of steel for continuous cold forging, characterized by 0.46 - 0.48 wt % of C (carbon), 0.14 or less of Si (silicon), 0.55 - 0.65 wt % of Mn (manganese), 0.015 wt % or less of P (phosphorus), 0.015 wt % or less of S (sulfur), 0.15 wt % or less of Cu (copper), 0.20 wt % or less of Ni (nickel), and 0.35 wt % or less of Cr (chromium), such that a limiting upsetting ratio of 90 % or more.

2. (Amended) A billet of steel for continuous cold forging, characterized by 0.46 - 0.48 wt % of C (carbon), 0.14 or less of Si (silicon), 0.55 - 0.65 wt % of Mn (manganese), 0.015 wt % or less of P (phosphorus), 0.015 wt % or less of S (sulfur), 0.15 wt % or less of Cu (copper), 0.20 wt % or less of Ni (nickel), and 0.35 wt % or less of Cr (chromium), such that a carbide of the billet has an aspect ratio of 300 % or less.

Claims 3-28 have been canceled.

Present Invention	JIS S48C	Ref. N (mass%)	Ref. O (wt%)	Ref. P (wt%)	Ref. Q (wt%)	Ref. R (wt%)
		JP7-34190	JP7-97656	JP9-176785	JP9-176786	JP7-300653
C:0.46～0.48wt%	0.45～0.51	0.1～1.5	0.30～0.60	0.20～0.70	0.2～1.2	0.15～0.5
Si:0.14 or less	0.15～0.35	0.5 or less	0.10 or less	1.50 or less	1.50 or less	0.1～2.0
Mn:0.55～0.65	0.6～0.9	0.1～2.0	0.15～0.65	0.3～2.0	0.3～2.0	0.05～2.0
P:0.015 or less	0.03 or less	0.005～0.15	0.10 or less	0.15 or less	0.15 or less	0.015 or less
S:0.015 or less	0.035 or less	0.005～0.25	0.10 or less	0.10 or less	0.10 or less	0.02 or less
Cu:0.15 or less	0.3 or less	0.1～3.0	0.50 or less	0.20 or less	0.20 or less	—
Ni:0.20 or less	0.2 or less	0.1～3.0	0.05～0.40	0.50 or less	0.50 or less	0.05～2.0
Cr:0.35 or less	0.2 or less	—	—	0.02～2.0	0.02～2.0	—

Table ~~2~~ 1:

	C	Si	Mn	P	S	Cu	Ni	Cr	Crack percentage (N=100)
JIS S48C	0.45～0.51	0.15～0.35	0.60～0.90	0.03 or less	0.035 or less	0.30 or less	0.20 or less	0.35 or less	20%
Mn reduced	↑	↑	0.55～0.65	↑	↑	↑	↑	↑	12%
Mn, C reduced	0.45～0.48	↑	0.55～0.65	↑	↑	↑	↑	↑	5%
Mn, C reduced Inclusions reduced	0.45～0.48	0.14 or less	0.55～0.65	0.015 or less	0.015 or less	0.15 or less	↑	↑	0%

Table 2:

Material	Process	Crack confirmation test	
		Upsetting test	Crankshaft formation
R material	Cutting→Acid pickling→Spherodizing annealing →Shot blasting +Bonderizing	8/10=80%	10/10=100%
Controlled rolling material	Cutting→Acid pickling→Spherodizing annealing →Shot blasting +Bonderizing	5/25=20%	2/30=7%
R material	Acid pickling→Spherodizing annealing→Acid pickling, Bonderizing→Drawing, Acid pickling→Spherodizing annealing→Shot blasting+Bonderizing	0/30=0%	0/30=0%
Controlled rolling material	Acid pickling→Spherodizing annealing→Acid pickling, Bonderizing→Drawing, Acid pickling→Spherodizing annealing→Shot blasting+Bonderizing	0/30=0%	0/30=0%
Surface-hardened steel (present invention)	Cutting→Acid pickling→Spherodizing annealing →Shot blasting+Bonderizing	0/20=0%	0/30=0%

Table ~~4~~ 3

Component	C	Si	Mn	P	S	Cu	Ni	Cr
Proportion (wt %)	0.46～0.48	0.14 or less	0.55～0.65	0.015 or less	0.015 or less	0.15 or less	0.2 or less	0.35 or less

Table ~~5~~ 4:

No	Aging time (300℃)
A	No aging
B	0.5H
C	1.0H
D	1.5H
E	2.0H
F	2.5H
G	4.0H(Over Aging)

Table ~~6~~ 5:

No	Hardness(HRC)			d value (A)
	Before aging	After aging	(Internal)	
A	23.3			2.0291
B	22.8	23.1	23.7	2.0300
C	23.4	23.6	24.5	2.0308
D	23.2	23.8	24.8	2.0308
E	23.4	23.9	24.5	2.0317
F	22.9	23.8	24.7	2.0300
G	23.4	23.7	24.4	2.0308

Table ~~1~~ 6:

Point	No1	No2	No3
1	23.9	23.5	23.4
2	23.4	23.4	23.8
3	23.7	23.0	23.2
4	23.5	23.4	23.4
Average	23.6	23.3	23.4

?

Table ~~8~~:

Point	No1		No2		No3	
	Surface	Internal	Surface	Internal	Surface	Internal
①	24.1	25.4	26.4	22.5	26.6	22.4
②	—	27.8	—	24.6	—	23.4
③	25.4	26.0	25.5	25.4	25.7	25.9
④	23.5	24.6	23.6	25.2	22.9	24.6
⑤	23.8	25.4	22.8	25.2	23.6	25.6
⑥	23.1	25.4	23.8	25.0	24.2	25.7
⑦	23.2	25.7	23.3	25.2	23.4	25.6
Average	23.9	25.8	24.2	24.7	24.4	24.7